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# Prehistoric Drawings in Mammoth Cave

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**I** am a senior in the Department of Anthropology, pursuing a second degree in sociology. I will receive honors in both departments, as well as from the UK Honors Program. In fall, 2007, I will begin a doctoral program in anthropology at Pennsylvania State University, studying archaeology and paleoethnobotany, topics with which I have become familiar through my coursework at

UK and my preparation of this thesis. George Crothers, my faculty mentor, introduced me to the topic of rock art during a trip to Salts Cave in 2006. I have had an interest in the subject since, and he has been extremely helpful and willing to provide resources and advice throughout the course of my research. My hobby of caving led directly to my involvement in this research, and my experience in Mammoth Cave as a cave guide over two summers helped familiarize me with the terrain and the subject. The cave area was my home before coming to UK, and it has remained an important and fascinating place for me. It has been very enlightening to conduct this research.



**Faculty Mentor:**  
**George M. Crothers, Ph.D., Assistant Professor,**  
**Department of Anthropology**

In his thesis, Logan Kistler builds a convincing argument that the enigmatic prehistoric drawings found in Mammoth Cave, Kentucky, represent entoptic phenomena resulting from use of the deep cave environment to induce altered states of consciousness. The neuropsychological model that Logan draws upon was originally used to explain similar representational forms found in rock art cross-culturally and through time from the Upper Paleolithic decorated caves in Europe to San shamanistic rock art in Southern Africa. These repetitive images have their origin in human ocular anatomy, which can be induced by sensory deprivation and other hallucinogenic stimuli. The exact conditions and cultural context that compelled prehistoric American Indians some 2000 years ago to render these geometric and abstract images in the dark recesses of Mammoth Cave still elude us, but Logan has made a convincing case that it represents a category of ritualistic human behavior better known from famous cave sites around the world. Logan demonstrates in this article that he has a very good command of diverse literature from neuropsychology to ethnopharmacology. However, for me, it demonstrates that all learning begins with simple exploration and wonder about the world around us. Logan found his world in the great underground.

## Prehistoric Drawings in Mammoth Cave

Excerpt from a Gaines Thesis

### Abstract

During a recent Earthwatch Institute survey of archaeological remains in Mammoth Cave, a project was begun to find and record prehistoric images on the cave walls. I chose to analyze petroglyphs and pictographs on three panels in Main Cave. This article offers a hypothesis for the circumstances surrounding the rock art's production: the geometric and anthropomorphic figures in Mammoth Cave are representative of a series of visual percepts experienced cross-culturally and caused by various conditions — including sensory deprivation, fatigue, and psychoactive drug use — acting on the ocular anatomy and nervous system. That is, the glyphs might be visual representations of simple hallucinations experienced by early cavers. These forms, “entoptic phenomena,” frequently occur in cave images and other artwork around the world, and are often ethnographically linked to shamanistic visions and other activities involving altered states of consciousness. The images in Mammoth Cave appear to represent several of the entoptic forms, and conditions of prehistoric cave exploration would have been ideal for experiencing them. Given this evidence, and considering the frequent use of caves for ritual activities across cultures, it is likely that Mammoth Cave Rock Art is linked to entoptic phenomena.

## Introduction

As they explored the underground maze of the Mammoth Cave system in the early nineteenth century, the slave guides, wealthy tourists, entrepreneurs, celebrities, and other visitors often left their signatures on the limestone walls and ceiling to memorialize themselves in some of the period's most remote known passages. Though historically fascinating and quite abundant, these mementos were left some two millennia after the first imagery in the cave — the geometric, sometimes anthropomorphic, and abstract images scratched lightly into limestone or drawn with the spent charcoal of the torches used to light the deep cave journeys. These puzzling images represent one form of evidence of early human exploration that has yet to be thoroughly scrutinized by archaeologists.

The glyphs occur in the cave well beyond the points at which natural light is visible, meaning that they were created using light from the torches brought in with the explorers (if indeed light were present during their creation). This fact, in conjunction with the large quantity of glyphs present, suggests that they were not created idly, but were made for some significant purpose. There are other Kentucky rockshelter and open-air rock art sites that likely align chronologically with the Mammoth Cave glyphs, but they are, for the most part, typologically and stylistically dissimilar to the abstract cave images (Coy et al., 1997). A few of the motifs commonly found in the Mammoth Cave imagery occur around the state and in the Green River drainage, but with very low frequency and with contextual settings — in terms of associated images and natural surroundings — different from those found in the cave.

The highly abstract Mammoth Cave rock art, therefore, should be considered to have its origins in a different social sphere from the images found at the open-air and rockshelter sites that share even the closest proximity to Mammoth Cave. While nearby surface sites reveal rock art likely created under environmental conditions familiar to the artists, the Mammoth Cave rock art was created in the unique setting of deep cave silence, darkness, and virtually unchanging climate. It is safe to assume that most members of the population would have had access to open-air sites, whereas the deep cave locations of rock art would likely have been visited by fewer people and for more specialized purposes. By assuming that deep cave sites would have been inaccessible to large portions of the population, and by contrasting the environmental conditions of open-air rock art sites and Mammoth Cave rock art sites, we can confidently suggest that both the social climate and the direct stimuli involved in the creation of the images were markedly different.

We will see later that the Mammoth Cave rock art can be viewed as typologically similar to images found in geographically and culturally unrelated sites, including the Maya center of Tikal, the California Great Basin, and Paleolithic sites in Europe (Haviland and Haviland, 1995; Lewis-Williams and Dowson, 1988). The Mammoth Cave images can be entered into inter-media comparisons with the embroidered artwork of the Huichol Indians in Mesoamerica (Furst, 1996), further illustrating the universality of the simple visual forms found in the Mammoth Cave system. The implication in these comparisons is that there is an underlying link that is not culture-specific between the origins of these abstract images in different world-regions. It is possible, even likely, that certain characteristics of human biology are responsible. This idea will be further explored when we begin to discuss the possible reasons for the presence of the abstract rock art in Mammoth Cave.

My field observations were taken during my period of employment at Mammoth Cave National Park, Division of Interpretation, in the summers of 2005 and 2006, and during a Cave Research Foundation trip into Salts Cave in February of 2006. My interest in the Mammoth Cave rock art has matured over the years along with my general knowledge of the area's prehistory. Rock art is a rare facet of the archaeological record that cannot be thoroughly studied through the extensive collection of existing publications dealing with Mammoth Cave archaeology.

In the following pages, I will present a hypothesis on the origin of the petroglyphs and pictographs of the Mammoth Cave system. I will discuss the possibility that the images represent visions originating in the ocular anatomy. These visions can be induced by sensory deprivation and several other stimuli, and are experienced cross-culturally with little variation. With the resources currently at my disposal, I cannot offer evidence beyond comparative analyses and hermeneutic arguments; but, with these tools of assessment, I intend to offer a set of conclusions that might be useful in future studies of rock art in the Mammoth Cave system and elsewhere.

## Archaeological Background of Mammoth Cave

The caves of south central Kentucky were used for a variety of activities by the area's prehistoric inhabitants. Mammoth Cave and Salts Cave (actually part of the Mammoth Cave system) are the two most studied in the region, with an abundance of research that began shortly after their modern re-discovery in the late eighteenth century. The first modern industry in the cave system was a saltpeter extraction operation (as indicated by the first deed, claimed by Valentine Simmons) that operated on its largest scale during the War of 1812. Saltpeter miners, mostly African American slaves, came into the first contact with prehistoric remains in Mammoth Cave. The "Audobon Avenue Mummy" was possibly the first remains of a prehistoric human encountered in historic times, found perhaps as early as 1810 by saltpeter workers (Meloy, 1968, pp. 16, 21). Much more evidence of human activity has been recovered (and much destroyed) since then.

The discovery of the Mammoth Cave Mummy, "Lost John," in 1937 marked a turning point in the archaeology of Mammoth Cave. Before that moment, it was still believed by some that the numerous artifacts deep in the cave were the result of events other than intensive cave exploration by prehistoric peoples. "There were some who even argued obstinately that the burned reeds that had been found in the cave had been washed in by freshets or ancient rivers and that the primitive grass

sandals had been carried in by pack rats” (Pond, 1937, p. 176). The human remains provided the incontrovertible evidence needed to convince all but the most reluctant skeptics. The Mammoth Cave Mummy was the first evidence of its kind to be discovered *in situ* after Nels Nelson’s introduction of systematic archaeological techniques to the cave in 1917 with his investigations in the Mammoth Cave Vestibule (Nelson, 1917). From then on, the questions were not centered on whether the cave was explored and used by prehistoric groups, but when, why, and to what extent.

A chronology has been established to demonstrate the era of heaviest use of the cave (see Figure 1). Kennedy and Watson (1997, p. 5) suspect two discrete periods of occupation and cave use, one in the late Archaic and the other in the early Woodland Periods. The first group left less evidence of intense resource exploitation and crop cultivation than the second, and there is a gap of about two hundred years between the two occupations. (1997, p. 5, Figure 1) These findings are consistent with typical subsistence patterns of indigenous populations in the area (Fagan, 2005, Ch. 17-18). The earliest date ( $4120 \pm 70$  B.P.) was recorded from the Mammoth Cave Interior, and is an outlier by several centuries; although, comparable dates have been taken from torch debris in nearby Lee Cave (Watson, 1974, p. 215). The most recent date ( $1920 \pm 160$  B.P.) was taken from internal tissue of the Salts Cave Mummy (or Little Alice, or Little Al), a flexed burial discovered in the late 19<sup>th</sup> century (Kennedy and Watson, 1997, p. 5; Meloy, 1968, p. 6).

Minerals were the primary cave material of interest to the prehistoric cavers, and a number of minerals were collected from the walls and floors of Mammoth and Salts Caves. Battering on the walls indicates prehistoric gypsum mining. Watson indicates that “pounding with ... sharp-edged rocks will dislodge an intermittent stream of gypsum powder which could have been caught in a gourd or basket by an assistant or which could have been allowed to fall on a cloth or hide spread at the foot of the wall. In many places the scars of these mining tools are discernable on the walls.” (1969, p. 60) Gypsum could have been used for some perceived medicinal benefits, for a whitewash pigment, or some other ritual purpose. (Watson, 1969, p. 58) Hadley (2006, Ch. 4) provides an extensive discussion of cross-cultural uses of gypsum.

Gypsum occurs in the cave in the form of elaborate “flowers” and “cotton,” as well as a crust covering large areas of the walls and ceiling throughout. We should not rule out the possibility of some value placed upon cave gypsum as a trade commodity and/or ritual material, due to the sheer amount of the mineral removed from the two caves. “The gypsum crystals could have served as charms, curiosities, or components in a medicine bundle” (Watson 1969, pp. 58-60; Watson, 1974, p. 232).

## Radiocarbon Age Determinations from Mammoth Cave and Salt Cave, Kentucky

*All representations are two-standard-deviation ranges*

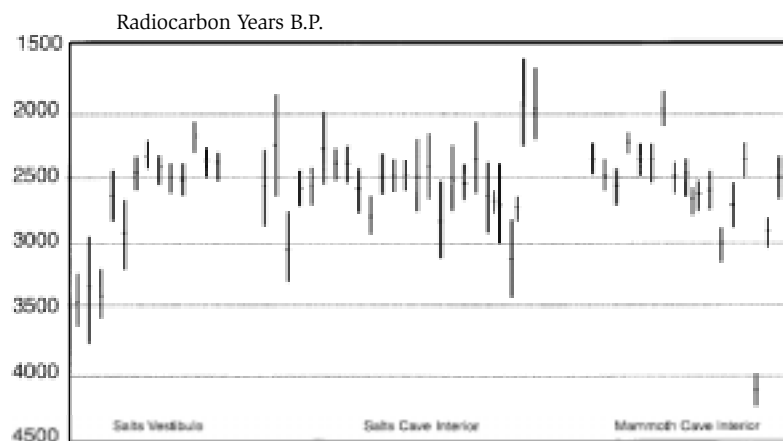


Figure 1. Use of Mammoth Cave (After Kennedy and Watson, 1997, p. 7)

Meloy (1968) characterized gypsum as a valuable ritual commodity for the prehistoric people in his discussion of the Mammoth Cave Mummy (or Lost John). “On the under side of the large block, the glitter of his reflected torchlight revealed the precious gypsum” (Meloy, 1968, p.16). Watson (1969, p. 58) points out that Meloy, like others, had the tendency to romanticize the significance of gypsum as a powerful ritual substance, especially with respect to the Mammoth Cave Mummy. “His faith in the sacredness of the tribal need for gypsum, precious ceremonial paint of the ancestors, had driven him on through the silence ...” (Pond, 1937). This type of depiction stretches well beyond the reach of any conclusions that can be drawn reasonably via archaeological evidence. Nonetheless, the climbing poles, mining tools, and walls stripped of gypsum well above the easy reach of an average-sized human indicate that for some reason it was vigorously sought by the prehistoric people.

Mirabilite was also removed from the caves, and was probably sought for its medicinal qualities as a cathartic (Watson, 1969, p. 58; Watson, 1974, p. 232). Experiments reported by Watson (1969, p. 58) show that when ingested in amounts of about two and two-thirds or more tablespoons (in its natural form as found in the caves), the cathartic effects are significant. Schoenwetter (1974, p. 56) indicates that “the mining of mirabilite for its medicinal properties seems wholly in keeping with the reconstruction of a high-roughage diet of stored seeds.” The mineral’s salty taste might also have made it a valuable resource for flavoring foods. Watson (1969, p. 58) believes there to be “no doubt that a salty mineral would be valued and probably widely traded.”

Chert was a third mineral gathered in the caves of south central Kentucky. Mammoth Cave, especially Flint Alley and Jessup Avenue, provided a supply of high quality chert for flint knapping. Salts cave provided only poor quality flint, and was not heavily exploited for this resource (Watson, 1974, p. 10). “At C10 [Jessup Avenue, Mammoth Cave] there is a vertical shaft with both nodular and tabular chert outcropping in it and near it ... Both kinds are of good quality and chunks of both have been smashed and battered out of the wall” (Watson, 1974, p. 188).



Surface survey revealed extensive chert use for the manufacture of flaked stone tools (Watson, 1974, pp. 3-15).

Archeological evidence from Salts and Mammoth Caves has contributed greatly to the study of the diet of the prehistoric people of south central Kentucky. Yarnell speaks of the “extraordinary yield of data essential to the reconstruction of ancient patterns of subsistence and ecology” preserved by the caves’ shelter and naturally curatorial static temperature and humidity (1974, p. 113); and Kennedy and Watson point out that the nutritional and dietary information gained from paleofecal analyses “provides the most detailed and best preserved such evidence available anywhere in the world for a prehistoric human group” (1997, p. 6).

Virtually all available published accounts of the early cavers’ diets indicate typical involvement in the Eastern Agricultural Complex (Fagan, 2005, p. 424). The gradual increase in certain plant remains over time suggests increasing use of native cultigens, specifically cucurbit, chenopod, maygrass, sunflower, and sumpweed (Yarnell, 1974, pp. 118-119). Paul Gardner (1987, p. 358) also mentions that non-native cucurbit was in the area by 4000 B.P., long before any known indigenous mining of the caves. By analyzing flotation samples from the Salts Cave Vestibule (later dated in the Early Woodland by Gardner [1987, p. 359]), Yarnell reconstructed a subsistence pattern of nearly two dozen varieties of plant food (1974, p. 120). Schoenwetter’s pollen and macrobotanical analyses also indicate seasonal exploitation of a number of wild fruits and berries, with almost constant use of fresh or stored chenopod, sunflower, hickory, and maygrass (1974, p. 52), and Yarnell’s analysis of the Salts Cave Mummy’s intestinal contents reveals the presence of animal protein and insect cuticle (1974, p. 109). Altogether, the evidence indicates subsistence through plant domestication and storage, heavily supplemented by seasonal hunting and gathering of local resources.

## Kentucky Rock Art as Context

Significant rock art research has been conducted around the state of Kentucky, revealing numerous petroglyph and pictograph sites. Coy et al. (1997) compiled a volume including over sixty rock art sites in Kentucky. The sites are not evenly distributed throughout the state, but cluster largely in the Eastern Mountains and the Pennyroyal region, including the Green River Drainage. Ison (2004) suggests that because the glyphs often occur in the two areas of heaviest early adoption of the Eastern Agricultural Complex, they might somehow be related to early crop domestication in the Late Archaic and Early Woodland Periods. He uses the frequent juxtaposition of bedrock mortars (hominy holes) and petroglyphs as evidence, pointing out that “rock art motifs and hominy holes are often found on the same boulder within shelters and ... never intrude on one another” (Ison, 2004, p. 183).

Common motifs at the Kentucky sites recorded and catalogued by Coy et al. include faunal elements, anthropomorphic elements, and abstract geometric figures. Bird tracks dominate the field, occurring at 31 of the sites. Human footprints occur at 15 sites, and all other motifs are significantly less common. Most of the areas are petroglyph sites, meaning the rock art is scratched or pecked into the surface without pigment. The only exception is the Mississippian Asphalt Rock pictograph site in Edmonson County, where the images are painted with natural red ochre (Coy et al., 1997, pp. 42-46). Geometric shapes and other forms similar to those represented in the Mammoth Cave system, such as spirals, zigzags, etc. occur at a number of Kentucky sites, but are often stylistically different. The High Rock petroglyph

site in Powell County shows a complex arrangement of geometric forms, but with thick, deeply-incised lines and what Coy et al. characterize as “Meso-American style” (1997, p. 153). Spirals appear at Dismal Rock in Edmonson County (1997, p. 41), Tar Springs in Butler County (1997, p. 15), and various other sites around the state, but often appear alongside bird tracks, as well as other glyphs and bedrock mortars.

The Burnt Ridge Petroglyph Site in Madison County (Coy et al., 1997, p. 94-96) has the most comparable anthropomorphic glyph to those appearing in Mammoth Cave, but the stylistic differences are profound. The Burnt Ridge figure has a bulbous head and linear body, limbs, and crude digits (all of the same width) carefully pecked into the stone surface. This style is in sharp contrast to the human figures in Mammoth Cave, which typically appear in a “corn-husk” style; that is, a trunk body represented by an area of vigorous vertical scratching, with arms and/or legs crafted in the same manner, sometimes with digits represented as single short lines incised at the distal ends of the limbs. They are occasionally depicted in positions suggesting movement, and are frequently represented either with no head or with what might have been intended as a head but is now (after centuries of mild wear) indistinguishable from the simple form of the body. Overall, the human figures cannot be described as anatomically or artistically precise, but only as basic representations of the human form. These glyphs are the only ones in the cave whose representative value can be interpreted in even the most basic terms with a moderate level of confidence. The highest concentration of human figures occurs on a panel known as Standing Rock (discussed below).

The contrasting styles of Mammoth Cave rock art and other Kentucky rock art are easily observed. Mammoth Cave rock art tends to be very superficial, each line scratched lightly with a single pass of a sharp implement (probably limestone cave debris used as an improvised drawing device, judging from the infrequency of flake-stone tools found in the cave interior) or drawn with charcoal from cane and wood torch remnants. There is nothing to indicate that significant time or artistic precision were spent creating the images. This is not surprising, bearing in mind that the artists would have been working only by the light of a limited number of torches; however, if the only factor preventing a higher level of precision in the deep cave glyphs were lack of light, it might be expected that we would find more expertly crafted images in the entrance and “twilight zone,” where natural light can still be seen from the surface. Because we do not find such glyphs near entrances, it seems that the expedience of production associated with the deep cave glyphs has little to do with

the time constraints imposed by the cave darkness. This idea is further diminished by experiments demonstrating the efficiency and ease of transport of *Arundinaria* sp., *Gerardia* sp., and other material commonly used as torches (Watson, 1969).

The rock art commonly found at surface sites in Kentucky is scratched or pecked into limestone or sandstone. The lines often have appreciable width and/or depth, indicating significant time and effort spent incising the glyphs. Coy et al. indicate that “the designs of the sites in Kentucky were well-executed. The bird tracks and turtle of Big Sinking Creek Turtle Rock ..., the ‘Meso-American style’ complicated design on the smaller rock of High Rock ..., and the many complicated designs of Turkey Rock ... are evidence of considerable skill in planning and execution” (1997, p. 153).

If the drawings in the Mammoth Cave system were intended by their artists to showcase the kind of workmanship described above, they would not appear as the haphazard, hastily created forms that are found in loose aggregates throughout the passages. People living in the same area during the same time period — and almost certainly culturally associated with the prehistoric cavers — were creating rock art in surface sites that have lead modern researchers to conclude that they were “careful craftsmen” (Coy et al., 1997, p. 153). Conversely, the superficial, abstract, repetitive rock art images of the Mammoth Cave system altogether indicate no careful planning or execution, but rather an *ad libitum* reaction to local stimuli or to some inexplicable expressive urges experienced in the unique setting of the deep cave.

The kind of superficial images found in the cave system would almost invariably have been destroyed by the two millennia of weathering since their inscription, if they were located in open-air sites. The protective cave environment has allowed the preservation of many faint images that would otherwise have been lost to the temperate weather patterns of the Eastern Woodlands. For this reason, we cannot be sure that these kinds of images were not drawn alongside those found today at surface sites, possibly even by the same artists; we might choose to use the environmental conditions to partially account for the absence of the cave-style glyphs at open air sites. There is virtually no way to test this hypothesis. What is certain is that if the kind of carefully designed and deeply incised glyphs that we see in surface sites were ever drawn in the cave, they would still be preserved and the only erosive effects would be those of historic human activity.

We can reasonably assume that, although some cave images may have been mimicked at surface sites, the vast majority of robust glyphs at surface sites never had counterparts in the cave system. Furthermore, the bird tracks, animal tracks, human hand and footprints,

and most of the other representative motifs found at contemporaneous sites near the Mammoth Cave system do not occur inside the cave. Because the Mammoth Cave glyphs are so anomalous in the context of Kentucky rock art, we should consider them to have originated in association with different activities, different direct stimuli, and/or in different social settings from those found at surface sites.

Surface glyphs have been loosely associated with bedrock mortars and thus early food production (Ison, 2004, p. 185). To draw a parallel to this economy/subsistence based origin, the deep cave rock art might well be associated with the well-documented gypsum and other mineral mining activities known to have taken place several miles from the entrance. The artists at surface sites would have been working in conditions generally consistent with the temperate weather patterns of the Eastern Woodlands, and with the option of daylight. The cave artists would have made their drawings by torchlight, in an environment virtually free of sound (except where water can be heard dripping through vertical shafts or flowing through underground streams and rivers), and with nearly constant temperature and humidity. They would also have been working with the awareness that they were a great distance from the surface, a condition that has been cross-culturally exploited in any number of ritual settings (Crothers, n.d.).

Sobolik et al. (1996) tested twelve Early Woodland paleofecal samples from the Mammoth Cave system for steroids, and based on their results determined that all twelve samples had been deposited by males. While this is too small a sample to be conclusive, it does suggest that a disproportionate number of males were involved in the activities taking place in the cave. On the other hand, Ison (2004, p. 187) suggests that rock art at surface sites in Kentucky, often associated with the processing of cultigens, might well have fallen under the responsibility of women. He discusses a common North American Indian division of labor, in which women were generally responsible for horticultural and plant-processing tasks. In addition to ethnographic and ethnohistorical literature, Ison (2004, p. 185) cites as evidence grave goods specifically linking women to plant-processing in sites containing petroglyphs associated with hominy holes. He argues that “[i]f a hominy hole was the personal property of a particular woman or the women of a nuclear family, then the boulder it was on was probably recognized as her property as well” and “the rock-art on these boulders could also fall under the category of women’s ownership” (Ison, 2004, p. 187).

Kentucky’s documented rock art sites form a significant element of the state’s archaeological record, thanks largely to the work of Coy et al. (1997). There are no doubt hundreds of undocumented glyphs left at open-air, rock shelter, and cave sites. However, the Mammoth Cave glyphs are significantly and undeniably different from the surface sites in Kentucky. This might be attributed in part to one or more of the above-mentioned differences between the two venues, or might be best explained by other variables. These observations can function as a starting point for the following interpretive discussion of Mammoth Cave rock art.

## Discussion of Mammoth Cave Rock Art *Description and Classification*

The Mammoth Cave imagery is assumed to originate largely from the Early Woodland period, aligning chronologically with the intensive mineral mining. This assumption is based on numerous dates taken from the cave interior, and a high volume of glyphs more likely associated with large-scale use of the cave rather than the “exploring, reconnoitering, or just caving for

sport” that was the probable purpose of much of the Archaic Period cave use (Kennedy and Watson, 1997, p. 5). It is to be hoped that direct dates will be determined from the images eventually, so that they may be more confidently associated with specific episodes and varieties of cave use. Taking direct dates from the Mammoth Cave glyphs would likely prove extremely difficult. The charcoal from the pictographs could be directly dated with AMS technology, but the resulting data would represent the time that the torches were originally used, not necessarily when the images were drawn. A glyph drawn today might easily be carbon-dated to the Early Woodland Period, as long as prehistoric torch debris (which is extremely abundant in the Mammoth Cave system) were used to create it. Thus, verification of the glyphs as authentically prehistoric is based on wear and patina accrued over the centuries, as well as the frequent superposition of historic graffiti over the images.



**Figure 2a. Devil's Looking Glass. Photo by Charles Swedlund, Richard Young pictured.**



**Figure 2b. Devil's Looking Glass. Photo by Charles Swedlund, Richard Young pictured.**

There will be no quantitative analysis of the glyphs for various reasons. The glyphs are often very faded, indistinct, and concealed by two centuries of historic graffiti; some areas, particularly sections of Lower Mammoth, are so completely covered in historic graffiti that any faint prehistoric images that once adorned the walls have likely been completely destroyed. Quantitative analysis would almost certainly yield incorrect results because of the destruction, obstruction, and general inconspicuousness of an unknown number and variety of prehistoric images in areas with extreme historic disturbance. Also, many areas of the cave have been surveyed for apparently prehistoric rock art, but because there has not yet been documentation of the images in all areas visited by Early Woodland cavers, I cannot reasonably assert that the search for rock art has been exhaustive. I will focus instead on the nature of a limited number of already-known glyphs.

Three panels (vertical standing rocks) of glyphs in Mammoth Cave are the primary locations of the rock art to be discussed in this paper. They will hereafter be referred to as Devil's Looking Glass, Standing Rock, and The Cataracts. Devil's Looking Glass and Standing Rock are so-named on the 1908 Max Kaemper map of Mammoth Cave (Watson, 1974, Figure 23.1). "The Cataracts" names the location of a narrow vertical shaft in Main Cave, which is the closest landmark to the third panel. Glyphs from Upper Mammoth Cave and Salts Cave not appearing on these panels will be discussed occasionally, based on personal observations made during my time in the Mammoth Cave system.

I have defined three main categories of imagery (not including historic elements) by which to classify the Mammoth Cave glyphs. These categories are largely for convenience, but do represent somewhat natural divisions based on differences in artistic emphasis, style, and/or the activities associated with their production. I will explain the classification system using examples from Devil's Looking Glass.

The charcoal pictographs on Devil's Looking Glass (Figures 2a-b) are some of the rock art specimens most frequently viewed and interpreted by park personnel and visitors to the cave. They lie in Main Cave, are accessible from the Historic Entrance, and are easily viewed from the developed trail. The panel is not in an area with electric lights, so plant and algal growth on the vertical rock have not been an issue. The images have been worn by historic activity, and are overlain by a number of historic graffiti. This makes rough authentication of prehistoric elements easier, but discerning them from their surroundings considerably more difficult.

"First order" images consist mainly of the kind of relatively bold images found on the lower right section of Devil's Looking Glass. I define them as glyphs created



by active human artistic agency (i.e., the image itself was the intended product of the activity that created it, and not the auxiliary effect of another activity, such as stoking of torch ends on the rock's surface to discard the spent portion). Also, they must be bolder, or created with more emphasis, than what we will call "second order" imagery, and must have clearly defined boundaries. On Devil's Looking Glass, a headless anthropomorphic figure, a vertical zigzag, and a small field of dash marks are included in this category. The zigzag has been problematic because it is significantly darker than the other first order images, suggesting a more recent creation or touch-up than the others. The topmost part of the zigzag appears fainter, roughly equal in wear to the anthropomorphic figure immediately to the left. This peculiarity suggests that at least part of the image can be safely considered prehistoric. Because the darker part blends smoothly with the lighter section, either: a) the artist applied increased pressure with the charcoal while drawing from the top down (or vice versa), creating the differential tones, or b) the artist who touched up the drawing subsequent to its original production traced part of the original pattern, leaving a small portion of the glyph untouched. To explain the boldness of this glyph it would be necessary to conduct a microstratigraphic analysis and/or direct dating.

Second order images are those glyphs whose boundaries are not defined clearly enough to be classified in the first order, and/or that were drawn significantly less boldly, generally with single lines scratched or of charcoal, and that were — like first order images — created actively by human artistic agency. On Devil's Looking Glass, second order images can be seen intermingled with the first order images discussed above. They are faint, sweeping parallel lines, nested curves, cross-hatching, and other vague shapes drawn lightly, and apparently with single strokes of the charcoal. They have no obvious representative value, and they are significantly more difficult to discern from their surroundings than the bolder first order glyphs, at least one of which was drawn using multiple strokes of the charcoal. Second order images at this location are very common, but easily overlooked in favor of the more dramatic first order pictographs.

"Third order," or residual imagery, is (effectively) two-dimensional evidence on rock faces of human activity other than rock art production. Residual imagery is not definable as rock art, because it was not created actively by human artistic agency. The primary examples of residual imagery are the stoke marks, or fields of these marks left when prehistoric cavers struck their torches on rock faces to discard the spent portion and expose a more combustible area of organic material. This is seen on Devil's Looking Glass near the center and on the left

side of the panel. Two areas of dense black soot appear as inverted cones on the lower left section, and should not be associated with prehistoric activity. They appear to be the effects of open-flame lanterns used in historic exploration (very possibly placed near the rock by early guides to show small tour groups the prehistoric artwork) or of the kerosene rag torches thrown by cave guides on tours until the early 1990's.

The Cataracts panel (Figure 3) shows two pairs of parallel zigzags drawn symmetrically across a vertical axis between them. These can be considered first order glyphs, and are considerably larger than the first order glyphs on Devil's Looking Glass. There are no conclusive second order glyphs on this rock face, but there is a form resembling a wheel with spokes scratched with single lines between the two zigzags on the left side that is possibly of prehistoric origin. A similar figure on Standing Rock appears to be prehistoric, and is the basis for my suspicion that this is also from the Woodland cavers. Two distinct areas of torch stoking (residual imagery) are apparent on the left side of the panel. All other human-made alterations to the Cataracts panel appear to be of historic origin.



*Figure 3. The Cataracts. Photo by Charles Swedlund, Richard Young pictured.*

Standing Rock (Figures 4a-e) is the site of the highest known concentration of anthropomorphic images in the cave system. The majority of the prehistoric imagery on Standing Rock is inconspicuous and appears on the side of the rock facing away from the developed trail, making it relatively little known and interpreted, especially compared to Devil's Looking Glass and the Cataracts. The images are mostly petroglyphs, scratched into the limestone. This makes them harder to distinguish than charcoal pictographs for two reasons: there is less contrast between the petroglyphs and the surrounding limestone, and they do not stand out as easily from historic graffiti scratched into the limestone around and often over them. However, careful examination and digital filtration make locating the petroglyphs a feasible task. Presumption of their bona fide prehistoric origin is based on relationships with abundant historic graffiti, including at least one signature each from 1810 and 1812.

The anthropomorphic figures on Standing Rock are similar in style — even though they are scratched, and not drawn with charcoal — to the anthropomorphic pictograph on Devil's Looking Glass. On Standing Rock, trunk bodies are represented by areas of vertical scratching with a sharp





*Figure 4a. Standing Rock. Photo by Charles Swedlund,*



*Figure 4b. Central portion of Standing Rock. Photo by Charles Swedlund,*



*Figure 4c. Standing Rock. Photo and digital filtration by Charles Swedlund,*

implement, probably a corner of a nearby fragment of limestone debris. Legs are sometimes drawn in the same fashion, but it is equally common for legs to be represented as a field of straight lines fanning downward and outward from the base of the body. Arms are present on some glyphs in the same style as the bodies, on some in the same individual line style as the legs, and absent on others. If heads are present on any of the glyphs, it is nearly impossible to tell because of wear and damage from historic activity. The anthropomorphic figures are defined more clearly than some of the other glyphs on Standing Rock, but stand out less than the human figure on Devil's Looking Glass. They are slightly more difficult to define than the charcoal pictograph because of: a) the extreme disturbance they have received from subsequent activity, b) the ambiguity of the boundaries and relationships amongst the human figures and with other glyphs, and c) (most importantly) the general difficulty involved with determining, some two thousand years after their creation, which petroglyphs were originally drawn with the most emphasis. (This emphasis is less obvious with petroglyphs than with the charcoal pictographs on Devil's Looking Glass.) All the anthropomorphic figures on Standing Rock are first order imagery, however the distinction is not as definite as with Devil's Looking Glass. This classification is based mainly on stylistic elements likening the human form on Devil's Looking Glass to those on Standing Rock, and on a general reluctance to lump these discrete, representative forms with the far more common and abstract second order glyphs interwoven between them.

Second order petroglyphs are nearly ubiquitous on the illustrated face of Standing Rock. They are present in the form of faint sweeping nested curves, concentric circles, cross-hatching, a wheel-and-spoke pattern, and straight parallel lines. The second order glyphs on this panel are almost always single-line patterns (i.e., made with a single pass of the drawing tool), as opposed to the vigorously scratched bodies and sometimes limbs of the human figures. They are not obviously representational of any tools, animals, or other material goods that might have been important to their artists. This is not to say that they should be immediately dismissed as representational of real-world objects, but if they are, we have basically no way of interpreting them.

Because the rock art images are so abstract as to leave us without a logical starting point for interpreting their meaning, it would be more profitable to try to answer the question of their origin. (I am less concerned with determining what these glyphs mean — because in many cases I have doubts that they represent anything physical at all — and more interested in why they take the abstract forms in which we find them, and why they are deep in Mammoth Cave system, a unique

setting of total darkness and nearly total silence.) In the following section, I will explore these questions through a broad hypothesis integrating a number of possible contributing factors to the manufacture of the rock art, including sensory deprivation associated with the deep cave environment, fatigue associated with mining and exploration, the stimulating effects of alkaloid chemicals found in plants associated with cave exploration, cross-cultural ritualism, and the hotly-debated subject of the role of entoptic phenomena and universal forms in rock art.

### *The Neuropsychological Model*

In the existing literature on the Mammoth Cave system, discussion of the pictographs and petroglyphs is extremely limited. There is little interpretation and certainly no consensus with regard to the meaning of the images or the social circumstances surrounding their origin. A small number of glyphs might reasonably be attributed to idle scratching or “doodling,” but the Mammoth Cave images are too numerous to suggest this possibility. The abstract glyphs also sometimes are interpreted as zoomorphic. This idea is misguided, given that nearby surface sites from the same time period show clearly representational zoomorphic forms (Coy et al., 1997). That is, the people who created the area’s rock art were capable of producing animal-like images if they so chose, and there is no evidence that the abstract glyphs represent the same kinds of entities. Therefore, interpreting Mammoth Cave’s zigzags, spirals, and other geometric images as zoomorphic is premature. Other ideas, including the following “neuropsychological model” (Lewis-Williams and Dowson, 1988, p. 202), might be usefully applied to the interpretation of the rock art of Mammoth Cave.

In a paper dealing with the possibility that male initiation rituals took place in the Mammoth Cave system, Crothers (n.d., p. 15) suggests that the rock art may be considered as evidence that “the prehistoric cave experience may have had supernatural overtones.” Although it is impossible to discuss the nature of Woodland Period rituals with a high level of specificity, the idea that the cave was the stage for ritual activity is likely, given the extensive cross-cultural occurrence of cave and kiva-based rituals (Crothers, n.d.). This concept plays a role in the following discussion of recurrent forms in visions experienced cross-culturally, and the possible importance of these forms in Mammoth Cave’s rock art.

This discussion of the significance of the Mammoth Cave rock art will be largely based on concepts proposed in the 1988 article “Signs of Our Times: Entoptic Phenomena in Upper Paleolithic Art,” by Lewis-Williams and Dowson. Therein, the authors argue that certain



*Figure 4d. Central portion of Standing Rock. Photo by Charles Swedlund, digital tracing by Logan Kistler.*



*Figure 4e. Concentric circles on Standing Rock. Photo by Charles Swedlund.*

patterns appear in rock art across time and space in unrelated cultures, and that these repeating forms may have their origins in the human ocular anatomy. They use the phrase “entoptic phenomena” (entoptic, from the Greek meaning “in the vision”) to describe the visions of these redundant forms, which are experienced by persons in contact with various stimulating conditions. The authors broadly describe the entoptic forms as “a feature of altered states completely controlled by the nervous system,” rather than “culturally informed hallucinations” (1988, p. 202). The implication is that the same forms are experienced regardless of cultural affiliation and can, therefore, occur in unrelated groups at any time the stimuli are present. Although Lewis-Williams and Dowson’s ideas on entoptic phenomena in prehistoric rock art have generated considerable debate and disagreement

(see comments in Lewis-Williams and Dowson, 1988), the neurological basis underlying the representative images found cross-culturally in cave art remains a viable hypothesis to explain the types of images found in Mammoth Cave. In light of the vast cross-cultural experience of these forms in ritual settings and their representation in cross-medial artwork, as well as a number of ideal conditions for their occurrence that are present in deep cave settings, a strong case can be made for the involvement of entoptic phenomena in much of the rock art in the Mammoth Cave system.

The work of Heinrich Klüver (1926) marked the beginning of systematic study dealing with redundant forms in visions associated with altered states. Klüver studied the hallucinatory effects of mescal buttons from the peyote cactus, and discovered certain recurrent shapes in the subjects' visions. Decades later, other scientists (see Lewis-Williams and Dowson, 1988, p. 202 for a complete list of relevant publications) recreated the results of Klüver's work by identifying similar redundant forms in test subjects' visions that "take geometric forms such as grids, zigzags, dots, spirals, and catenary curves ... experienced as incandescent, shimmering, moving, rotating, and sometimes enlarging patterns" (1988, p. 202). The stimuli that have been demonstrated to produce these percepts include electrical stimulation, flickering light, psychoactive drug use, sensory deprivation, fatigue, rhythmic movement, intense concentration, hyperventilation, auditory driving, and schizophrenia (1988, p. 202). I will point out for later discussion that several of these stimuli could very conceivably have been common circumstances under which prehistoric Mammoth Cave exploration took place, especially in view of the likelihood of some ritual use of the cave.

Lewis-Williams and Dowson consider San shamanistic rock art from Southern Africa, Coso shamanistic rock art from the California Great Basin, and Upper Paleolithic cave art in France for their study, which is the first published link between entoptic phenomena and rock art. The authors construct a model of three stages of mental imagery experienced in altered states of consciousness by drawing on twentieth-century experimentation

**Figure 5. The Six Basic Entoptic Forms with Examples from Various Sites (redrawn from Haviland and Haviland, 1995, Figure 1, which is based on Lewis-Williams and Dowson, 1988)**

ENTOPTIC PHENOMENA			SOUTH AFRICAN ROCK ART		COŌO	EUROPEAN PALEOLITHIC ART			
			ENGRAVINGS	PAINTINGS		MOBILE ART		PARIETAL ART	
	A	B	C	D	E	F	G	H	I
I									
II									
III									
IV									
V									
VI									

and shamanistic practices, and they apply the model to the rock art in various settings to explain cross-cultural similarities and culture-specific elements in each. The work is based on neuropsychological research performed in laboratories working independently of one another, a condition that they suggest "greatly reduces the inferential component" in their argument (Lewis-Williams and Dowson, 1988, p. 213).

The first stage of their three-stage model consists of the perception of entoptic forms consistent with numerous accounts derived from laboratory experiments. The visions cannot be consciously controlled or acted upon, and are focused at reading distance. They are sometimes bright and colorful, and can occur even in the total absence of light with eyes open or closed. The forms change rapidly, and are generally described as having a "life of their own" (Lewis-Williams and Dowson, 1988, p. 203). Because these visions are supposedly produced by interactions between the stimulated nervous system and ocular anatomy (and not the subject's knowledge and experience), they do not depend on cultural background, and thus occur across cultures with high consistency (1988, p. 202). The authors selected six of the most common entoptic forms for consideration, and defined them as follows: "1) A basic grid and its development in a lattice and expanding hexagonal pattern, 2) sets of parallel lines, 3) dots and short flecks, 4) zigzag lines crossing the field of vision (reported by some as angular, by others as undulating), 5) nested catenary curves (in a developed form the outer arc comprises flickering zigzags), and 6) filigrees or thin meandering lines" (1988, p. 203). They note that there is variation, but these are considered to be fundamental forms based on their abstraction from numerous reports. Their illustrations of these six basic forms alongside examples of rock art in

which they occur from their areas of study have been reproduced here as figure 5.

The second stage of their model involves the subject's conscious or unconscious manipulation of the entoptic forms into familiar images. In other words, they try to "make sense of entoptics by elaborating them into iconic forms." (Lewis-Williams and Dowson, 1988, p. 203) Because this stage is based on the subject's own experiences and knowledge, the visions are — unlike the first stage visions of purely entoptic forms — dependent on cultural setting. The authors describe how this stage is sometimes embraced in ritual contexts: "during the period of his training a Samoyed shaman is encouraged to 'guess' what each element in his vision represents (Siikala, 1985)" (Lewis-Williams



and Dowson, 1988, p. 210). This “guessing” leads to willful manipulation of the visions into iconic forms. The rock art that is created to represent this stage of mental imagery is supposedly an intermediary between purely entoptic and purely iconic forms, integrating the basic entoptic forms into culturally relevant iconic ones (see figure 5 for examples).

The authors describe the shift into the third stage as follows:

As subjects move ... into Stage 3, marked changes in imagery occur (Siegel, 1977, p. 132). Many laboratory subjects report experiencing a vortex or rotating tunnel that seems to surround them, and there is a progressive exclusion of perceptual information (Horowitz, 1975, p. 178). The sides of the vortex are marked by a lattice of squares like television screens. The images on these ‘screens’ are the first spontaneously produced iconic hallucinations; they eventually overlie the vortex as entoptics give way to iconic images (Siegel and Jarvik, 1975, pp. 127, 143; Siegel, 1977, p. 136) ... Subjects stop using similes to describe their experiences and assert that the images are indeed what they appear to be. They ‘lose insight into the differences between literal and analogous meanings.’ (Siegel and Jarvik, 1975, p. 128) ... [I]conic imagery is ‘often projected against a background of [entoptic] geometric forms’ (Siegel, 1977, p. 134) (Lewis-Williams and Dowson, 1988, p. 204).

In this third stage of mental imagery, the subject sometimes experiences complex integration of him or herself into the hallucination, and can “transform” into an element of the vision. Sometimes the subject can be integrated into an iconic part of the hallucination; “I thought of a fox, and instantly I was transformed into that animal. I could distinctly feel myself a fox, could see my long ears and bushy tail, and by a sort of introversion felt that my complete anatomy was that of a fox (Siegel and Jarvik, 1975, p. 105)” (Lewis Williams and Dowson, 1988, p. 212). In other cases, subjects report that in the midst of extreme sensory confusion associated with altered states of consciousness, their own anatomical appendages can appear to be composed of entoptic forms; “[The subject] felt his legs consisted of ‘spirals’ and that these somatic spirals blended with a luminous spiral rotating in the visual field ... Another subject reported that he became identical with an entoptic ‘fretwork’ pattern as his arms, hands and fingers turned into fretwork: ‘The fretwork is I’ (Berenger, cited by Klüver, 1942, p. 182)” (Lewis-Williams and Dowson, 1988, p. 211). Lewis-Williams and Dowson (1988, p. 211) apply the third stage concept to San images of humans

with zigzag legs and Coso anthropomorphic figures frequently decorated with entoptic patterns. The “vortex” often accompanying the third stage of mental imagery is, for the authors, probably the represented subject of the concentric circles and/or spirals that occur frequently in their subjects’ rock art (Lewis-Williams and Dowson, 1988, p. 205).

The authors note that these stages are not necessarily sequential, but often occur in conjunction with one another (1988, p. 204). Therefore, a shaman, or other person experienced with visions derived from altered states might well learn to associate entoptic forms with more involved iconic forms and, eventually, hallucinatory trances in which the subject is totally integrated into his or her mental vision. This principle makes the entoptic forms — which, alone, have no grounding in the subject’s cultural background — strongly related to the powerful iconic images and complex multi-sensory hallucinations that play a major role in cross-cultural ritual activity. The Huichols of Mexico actively associate entoptics with complex visions in this way: “[t]he first [stage of peyote-induced phosphene images] involves brightly colored geometric imagery in motion, called *nierika* by Huichols, in reference to sacred designs that serve as portals to other worlds” (Schaefer, 1996, p. 156). This associative relationship can, as is the case with the Huichols, lead to a high level of importance being placed on entoptic forms.

The relationship of entoptic forms to the rock art discussed in Lewis-Williams and Dowson’s article is clear and well-demonstrated. In addition to the San, Coso, and Upper Paleolithic rock art discussed in that article, the neuropsychological model has been applied to images found at the Maya center of Tikal (Haviland and Haviland, 1995). Furthermore, images consistent with entoptic forms can be found in the embroidery of the Huichols. “They feel it is their duty to record these psychedelic patterns in their weaving and embroidery designs after they have returned home” (Schaefer, 1996, p. 157). The ideas are further supported by accounts of *yajé*-induced visions in the Colombian Amazon that include descriptions of “innumerable scintillating” visions of “grid patterns, zigzag lines and undulating lines, many-coloured concentric circles or endless chains of brilliant dots” (Reichel-Dolmatoff, cited by Lewis-Williams and Dowson, 1988, p. 204).

### ***Entoptic Phenomena in Mammoth Cave Rock Art***

To build an argument for this theory, I will first revisit the stimuli that are known to produce mental imagery with entoptic forms, and describe how several of these stimuli could have been part of the prehistoric Mammoth Cave experience. If we eliminate electrical stimulation as a possible stimulus, we are left with flickering light, sensory deprivation, fatigue, intense concentration, hyperventilation, psychoactive drug use, rhythmic movement, auditory driving, and schizophrenia (Lewis-Williams and Dowson, 1988, p. 202). I would reject schizophrenia as a possible stimulus on the grounds that it cannot explain any widespread experience of entoptic forms in a normal population, and is not specific to the cave environment. Rhythmic movement and auditory driving, though possibly present at the time of the glyphs’ creation, I have also eliminated from the following discussion.

Of the remaining six stimuli, flickering light and sensory deprivation are the most likely to have been factors, inasmuch as they were almost definitely experienced on prehistoric journeys into the cave. The open flames from torches used to light the way would have been flickering constantly and casting quick-moving shadows around the passageways, and, in the event that their torches failed, total and immediate loss of any visual



cues from the environment would occur. When traveling alone, absolute silence (except in the presence of moving water) would also have been a condition of the deep cave experience. Loss of these two most essential senses is met by total disorientation and sometimes, according to sources cited by Lewis-Williams and Dowson (1988, p. 202), perception of the geometric forms attributed to entoptic phenomena. Furthermore, the natural darkness of caves has been a sought-after environment for a number of well-documented ritual activities (Crothers, n.d.). If we accept the likelihood of Mammoth Cave as a ritual setting, this lends credence to the idea that it was sometimes used specifically for its sensory-poor environment. It is also possible that a combination of ritual activity (e.g., seclusion) and the sensory-poor environment induced entoptic phenomena as a byproduct. That is, experiencing entoptic phenomena might not have been the purpose of the activity, but conditions were ideal for them to occur.

Psychoactive drug use is often an integral part of shamanistic and other ritual activities across space and time (see, for numerous examples, Schultes et al., 2001). If ritual activity were taking place in Mammoth Cave, it is possible that psychoactive substances were involved. Pollen analyses of paleofeces from Mammoth and Salts Cave have indicated the presence of sweet flag (*Acorus calamus* L.) pollen in at least four of 26 samples analyzed in two separate studies; and, in each of the four samples it occurs at levels high enough to be rejected as a result of accidental ingestion (Schoenwetter, 1974, pp. 52-57; Bryant, 1974, pp. 205-208). Sweet flag is a native perennial herb with well-documented medicinal uses associated with the volatile oils in the rhizome (Erichsen-Brown, 1979, pp. 230-233; Bruneton, 1999, pp. 571-572; Motley, 1994). Asarone, one of the essential oil's components, is chemically similar to mescaline and can induce "an experience similar to LSD" in some subjects (Motley, 1994, p. 399). In addition to medicinal use in multiple capacities, it is recorded as having been used for the hallucinogenic effects of the alkaloids in its volatile oils and as a stimulant — to relieve fatigue associated with physically taxing activities — by some Native American groups (Moerman, 1998, p. 46; Motley, 1994, p. 399).

Though there is no known ethnobotanical use of the pollen or flowering parts of sweet flag, the extremely varied uses of the rhizome are ethnographically well-known and often exploited in most, if not all inhabited areas where the plant occurs (Motley, 1994). I am inclined to believe that, because the prehistoric cavers had access to the plant and were using the flowering parts, they were also aware of the medicinal and/or psychoactive effects of the rhizome. They well might have been using the plant for its stimulant effects. The large-scale gypsum mining would have required that individuals travel deep into the cave for long periods of time to procure the mineral, and the fatigue associated with these journeys could have been alleviated by a stimulant. In this capacity, sweet flag's use is comparable to the use of coca as a general stimulant in South America (South, 1978). It also could have been used in this way to counteract the effects of the persistent cold in the cave. If this use of sweet flag were commonplace, it is likely that its hallucinogenic properties would have been experienced occasionally as a side-effect of using more than the desired amount. It is also possible that the plant was exploited specifically for its hallucinogenic value, either as a "recreational" drug or in some ritual capacity. In either case, the use of the sweet flag rhizome inside or prior to entering Mammoth Cave is a strong possibility and satisfies the criteria of psychoactive drug use as a possible contributing factor to the perception of entoptic forms therein.

As mentioned before, fatigue would likely have been a regular part of deep-cave gypsum mining expeditions. In addition, the long ordeals of solitude in caves and similar environments that are sometimes part of cross-cultural initiation rituals (Crothers, n.d.) could be sources of extreme mental and physical fatigue, based on the social gravity of the experience, the unfamiliar setting, possible tasks involved, and general anxiety felt by the subject. If fatigue were indeed felt by prehistoric cavers, it is the fourth possible stimulus of the cave setting known to trigger visions of entoptic forms. Intense concentration (though easily the most vague of the stimuli) could be likewise associated with either the mining activities or, even more so, ritual activities involving tasks and settings both unfamiliar to the subject and important to his/her social position.

Hyperventilation is the final stimulus. This can occur as a physical response to (among many conditions) anxiety and nervousness, stress, and stimulant use (Kaufman, 2006). I have discussed how these conditions were likely to have been involved in at least some of the prehistoric deep cave journeys, and it follows that hyperventilation could have been triggered by elements of the experience.

I have provided several viable situations in which one or more of the stimuli indicated by Lewis-Williams and Dowson (1988, p. 202) to trigger the perception of entoptic forms could have occurred in the Mammoth Cave system. By comparing the grids, spirals, concentric circles, sweeping nested curves, zigzags, fields of dash marks, and parallel lines that occur in Mammoth Cave rock art — comprising some of the first order and virtually all of the second order imagery — with descriptions of entoptic phenomena and with art known to represent them, we see that the similarities are uncanny.

## Conclusions

It is impossible to determine with certainty the meaning behind any abstract rock art whose creators have not left direct evidence of its significance. However, there is strong evidence to show that conditions were right for the perception of entoptic forms by prehistoric explorers in Mammoth Cave, and the rock art created by these early cavers takes the ideal forms to support this hypothesis. Not only do the simple entoptic forms occur frequently, but the anthropomorphic figures' irregularities (missing heads or limbs, legs and arms represented by parallel lines) might be attributed to more complex visions in which the subject feels him- or herself transform and be integrated into the entoptic and/or iconic images. The superposition of these anthropomorphic figures over the geometric second order petroglyphs on Standing Rock can almost be viewed as an illustration of the previously quoted passage: "[I]conic imagery is often

projected against a background of geometric forms.” Furthermore, I have provided a hypothesis by which the simple geometric forms occurring in Mammoth Cave are not dismissed as the “idle doodlings of bored novices” as has been the case with similar rock art (Haviland and Haviland, 1995, p. 295), thus refuting an explanation that does not concord well with the volume and consistency of the glyphs. Overall, the evidence — likely presence of the right stimuli, Mammoth Cave glyphs as entoptic forms, cross-cultural ritual practices, dissimilarity to nearby surface glyphs, etc. — makes the hypothesis of entoptic forms’ influence in the rock art of Mammoth Cave a plausible model for explaining its origin.

Visual representation of one’s surroundings and experiences is a tradition dating from well before the peopling of the Americas. Rock surfaces are frequently the chosen places for such representation, but as Coy (2004, pp. 3-4) points out, “the frequency of reported rock-art sites diminishes as one progresses from the west to the east in the United States.” He proceeds under the premise that “the preponderance of picture writing on nonportable surfaces done by the northeast Native Americans was more often executed on trees rather than on rocks.” If Coy’s hypothesis is correct, it is likely that a high percentage of prehistoric Eastern Woodland drawings have been long lost, leaving only the best-preserved specimens for our study. In that case, the surviving Kentucky rock art, including what is found in the Mammoth Cave system, probably represents only a small fraction of the pictographs and engravings once created in the area.

I make this observation to demonstrate that Mammoth Cave was probably not the site of as large a proportion of all prehistoric artwork as it represents today. The rock art therein should be interpreted differently from surface rock art that is seemingly in step with day-to-day activities. When we find such images in a unique environment such as a deep cave setting, we should not fail to consider that unusual circumstances — including the possibility that the artists willingly or accidentally perceived universal geometric forms — played a role in their creation. In accordance with this tenet, I have presented and argued the hypothesis that the rock art of Mammoth Cave represents the same entoptic forms recorded by Paleolithic artists in France, Maya workers at Tikal, Huichol embroiderers, San and Coso shamans, and very likely others throughout history.

It is important to reiterate that direct evidence in support of this idea is scarce. Cross-cultural comparisons and theoretical reconstruction of the prehistoric cave experience indicate that the early cavers likely experienced visions of entoptic forms while inside the cave, possibly caused by conditions of mineral mining and exploration or during ritual activities. A reasonable model is that the early cavers accidentally discovered

entoptic visions while exploring the cave, and, like the Huichols, integrated them into a broader shamanistic complex. This would explain why the forms were important enough to record so frequently as rock art. While we cannot be sure of the exact circumstances of the glyphs’ creation, future archaeological research in Mammoth and Salts Caves can help us understand and reconstruct the broader nature of early cave exploration, and possibly provide insight into the rock art’s origin.

Additional research into the use of extracted gypsum would be extremely valuable, if reasonable results could be obtained. This evidence could help us better understand the nature of mineral mining, and possibly the social dynamic of the activity. Direct dating of the rock art would confirm or disconfirm that it was created during the time of the large-scale mining activities in the Early Woodland Period. This could indicate the importance of a possible relationship between the rock art and intensive mining of gypsum and other minerals. In addition, an exhaustive search and recording of rock art in Mammoth and Salts Cave would help us better quantify, classify, and analyze the glyphs. Paleoethnobotanical investigations could help determine the frequency of sweet flag use on early cave journeys, and might yield direct evidence of use of the plant’s rhizome. Additional sex determination of the depositors of paleofecal remains by steroid analysis would be valuable for making statements about gender roles in deep cave activities, including rock art production. With constantly improving technologies and methodologies, future investigations may be able to expand on the existing bank of literature on the archaeology of Mammoth Cave, and may bring us closer to a clear understanding of the petroglyphs and pictographs within.

## Bibliography:

- Bruneton, Jean. *Pharmacognosy, Phytochemistry, Medicinal Plants*, (2nd ed.) London: Intercept, 1999.
- Bryant, Vaughn M. Jr. “Pollen Analysis of Prehistoric Human Feces from Mammoth Cave.” In *Archaeology of the Mammoth Cave Area*. Ed. Patty Jo Watson. New York: Academic Press, 1974. pp. 203-209.
- Coy, Fred E. Jr. “Native American Dendroglyphs of the Eastern Woodlands.” In *The Rock-Art of Eastern North America*. Eds. Carol Diaz-Granados and James R. Duncan. Tuscaloosa, AL: University of Alabama Press, 2004.
- Coy, Fred E. Jr., Thomas C. Fuller, Larry G. Meadows, and James L. Swauger. *Rock Art of Kentucky*. Lexington, KY: The University Press of Kentucky, 1997.
- Crothers, George M. “Ritual Use of Caves in Eastern North America During the Early Woodland Period.” Manuscript in Preparation. (n.d.)
- Erichsen-Brown, Charlotte. *Medicinal and Other Uses of North American Plants*. Mineola, NY: Dover Publications, 1977.
- Fagan, Brian. *Ancient North America*. London: Thames and Hudson, Ltd, 2005.
- Gardner, Paul. “New Evidence Concerning the Chronology and Paleoethnobotany of Salts Cave, Kentucky.” *American Antiquity* 52.2 (1987): 358-367.
- Hadley, Alison Marie. “Early Woodland Gypsum Mining and Torch Debris in Mammoth Cave National Park, Kentucky.” Unpublished Masters Thesis, Department of Anthropology, University of Kentucky, Lexington. (2006).
- Haviland, William A., and Anita de Laguna Haviland. “Glimpses of the Supernatural: Altered States of Consciousness and the Graffiti of Tikal, Guatemala.” *Latin American Antiquity* 6.4 (1995): 295-309.
- Ison, Cecil R. “Farming, Gender, and Shifting Social Organization. In *The Rock-Art of Eastern North America*. Eds. Carol Diaz-Granados and James R. Duncan. Tuscaloosa, AL: University of Alabama Press, 2004. 177-189.

- Kaufman, David A. "Medline Plus. A Service of the U.S. National Library of Medicine and the National Institutes of Health." 2006. February 25, 2007. < <http://www.nlm.nih.gov/medlineplus/print/ency/article/003071.html> >
- Kennedy, Mary C, and Patty Jo Watson. "The Chronology of Early Agriculture and Intensive Mineral Mining in the Salts Cave and Mammoth Cave Region, Mammoth Cave National Park, Kentucky." *Journal of Cave and Karst Studies* 59.1 (1997): 5-9.
- Klüver, Heinrich. "Mescal Visions and Eidetic Vision." *American Journal of Psychology* 37 (1926): 502-515.
- Lewis-Williams, J. D., and T.A. Dowson. "The Signs of All Times: Entoptic Phenomena in Upper Palaeolithic Art." *Current Anthropology* 29.2 (1988): 201-245.
- Meloy, Harold. *Mummies of Mammoth Cave; an account of the Indian mummies discovered in Short Cave, Salts Cave, and Mammoth Cave, Kentucky*. Shelbyville, IN, 1968.
- Motley, Timothy J. "The Ethnobotany of Sweet Flag, *Acorus calmus* (Araceae)." *Economic Botany* 48.4 (1995): 397-412.
- Moerman, Daniel E. *Native American Ethnobotany*. Portland, OR: Timber Press, 1996.
- Nelson, Nels C. "Contributions to the Archaeology of Mammoth Cave and Vicinity, Kentucky." *Anthropological Papers of the American Museum of Natural History* 22.1 (1917):1-73
- Pond, Alonzo. "Lost John of Mummy Ledge." *Natural History* 39 (1937): 180-186.
- Schoenwetter, James. "Pollen Analysis of Human Paleofeces from Upper Salts Cave." In *Archaeology of the Mammoth Cave Area*. Ed. Patty Jo Watson. New York: Academic Press, 1974. pp. 48-59.
- Schultes, Richard Evans, Albert Hofmann, and Christian Rätsch. *Plants of the Gods, Their Sacred, Healing, and Hallucinogenic Powers*. Rochester, VT: Healing Arts Press, 2001.
- Schaefer, Stacy B. "The Crossing of the Souls Peyote, Perception, and Meaning among the Huichol Indians." In *People of the peyote: Huichol Indian history, religion, & survival*. Ed. Stacy B. Schaefer and Peter T. Furst. Albuquerque: University of New Mexico Press, 1996. pp. 138-168
- Siegel, R.K. "Hallucinations." *Scientific American* 237 (1977): 132-140.
- Siegel, R.K., and M.E. Jarvik. "Drug-Induced Hallucinations in Animals and Man." In *Hallucinations: Behaviour, Experience, and Theory*. Eds. R.K. Siegel and L.J. West. New York: Wiley, 1975. pp. 81-161.
- Siikala, A. "Comment on: Mental Imagery Cultivation as a Cultural Phenomenon: The Role of Visions in Shamanism, by R. Noll." *Current Anthropology* 26 (1985): 455-456.
- Sobolik, Kristen D., Kristen J. Gremillion, Patricia L. Whitten, and Patty Jo Watson. "Technical Notes: Sex Determination of Prehistoric Human Paleofeces." *American Journal of Physical Anthropology* 101 (1997): 283-290.
- South, Robert B. "Coca in Bolivia." *Geographical Review* 67.1 (1978): 22-33.
- Watson, Patty Jo. *The Prehistory of Salts Cave, Kentucky*. Springfield, IL: The Illinois State Museum, 1969.
- Watson, Patty Jo. "Lee Cave." In *Archaeology of the Mammoth Cave Area*. Ed. Patty Jo Watson. New York: Academic Press, 1974. pp. 215-219.
- Watson, Patty Jo. "Observations in Upper and Lower Mammoth." In *Archaeology of the Mammoth Cave Area*. Ed. Patty Jo Watson. New York: Academic Press, 1974. pp. 185-192.
- Watson, Patty Jo. "Prehistoric Miners." In *Archaeology of the Mammoth Cave Area*. Ed. Patty Jo Watson. New York: Academic Press, 1974. pp. 231-232.
- Watson, Patty Jo. "Survey and Excavation in the Vicinity of Salts Cave." In *Archaeology of the Mammoth Cave Area*. Ed. Patty Jo Watson. New York: Academic Press, 1974. pp. 3-18.
- Yarnell, Richard A. "Intestinal Contents of the Salts Cave Mummy and Analysis of the Initial Salts Cave Flotation Series." In *Archaeology of the Mammoth Cave Area*. Ed. Patty Jo Watson. New York: Academic Press, 1974. pp. 109-112.
- Yarnell, Richard A. "Plant Food and Cultivation of the Salts Cavers." In *Archaeology of the Mammoth Cave Area*. Ed. Patty Jo Watson. New York: Academic Press, 1974. pp. 113-122.

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